

Microwave-Based Water Decontamination System

Diane Byerly, Johnson Space Center
George Arndt, Johnson Space Center

Marguerite A. Sognier,
Universities Space Research Association
John Dusi, Jacobs Technology

One challenge for the International Space Station (ISS) and future crewed space exploration is to produce sufficient quantities of potable water to meet mission requirements. Current ISS water treatment includes the use of iodine, which produces undesirable health effects and does not eliminate issues related to bacterial contamination of water systems. In addition, research performed on the ISS has shown that bacteria in space can mutate into strains that are more resistant and difficult to eradicate. Alternate approaches are needed—approaches that can effectively eliminate bacteria, are chemical free, and require minimal or no consumables.

The Biomedical Engineering Technology Development Team at Johnson Space Center developed an innovative water purification method that uses selected frequencies of microwave energy to effectively kill bacteria in water. This prototype system is based on a modified version of a small, lightweight, handheld microwave system that was previously developed and tested for medical and dental applications.

Preliminary testing identified specific microwave frequencies and exposure times for killing *Burkholderia cepacia*—a bacteria known to be present in the ISS water system. Waterborne bacteria was intermittently and randomly circulated for 4 weeks in a growth chamber to simulate a water filtration system. Bacteria adhered to and grew on the flat surfaces of the chamber, forming biofilms. These bacterial biofilms were irradiated with high-frequency microwave energy for various time intervals in static (non-circulating) water. The test results showed that exposure to microwave energy for 1.5 minutes could effectively kill waterborne bacteria within the chamber and also bacterial biofilms.

The next series of tests involved the assessment of bacterial kill in a circulating water test bed. The system was configured so that the water flowed through a series of hairpin loops during microwave exposure. Using this system, the waterborne bacteria could be effectively eradicated in 30 seconds.

This microwave-based technology could be used for different space applications including generation of purified water using an in-situ system in which circulating

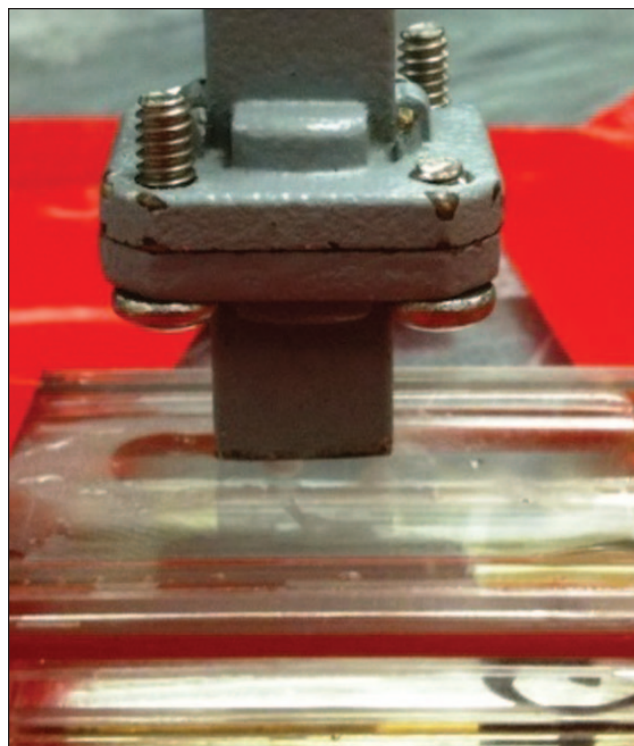


Fig. 1. Radio frequency exposure of water borne bacteria and bacterial biofilms in test chamber.

water is continuously subjected to microwave energy. The specific frequency of the microwave energy used allows the bacteria in circulating water to selectively absorb the energy, thereby killing the bacteria. Other applications include a modified version of this system, which could be used to eliminate bacteria accumulation in existing water cooling loops and heat exchangers. Since this system is portable, it could extend the life of existing water filters, prevent the growth of bacteria entering a water storage system at the inlet, and add a level of redundancy to currently existing purification systems.

Once fully developed, this technology could be used for space exploration as well as commercial space flight including spacecraft, habitats, spacesuits, and rovers. It would also have a broad range of applications on Earth such as battlefield/field treatments for the military, isolated geographical areas, and hospital/research environments.